

## INSTITUTE OF CURRENT WORLD AFFAIRS

JEF-18

Who Gets Modern Technology?

150 Soi 20 Sukhumvit Road  
Bangkok 11, Thailand  
April 15, 1975

Mr. Richard H. Nolte  
Institute of Current World Affairs  
535 Fifth Avenue  
New York, New York

Dear Mr. Nolte:

The whole world has been converted to the religion of development, crudely interpreted to mean increasing product per person. In the earlier stages of man's history, the major factors in such development were increases in cultivated land and the capital stock. Modern growth, on the other hand, relies on technology. For the peoples of the less developed world, these two routes offer a tantalizing prospect -- in the classical sense of something forever out of reach. Growth by one's own capital accumulation is an agonizingly slow process: compound interest is just not fast enough to satisfy aspirations shaped by the prodigal example of today's advanced countries. In principle technology is the modern world's answer to the slowness of capital accumulation, but its application in practice is laden with difficulties, and the results, problematic. For one, the use of the new technology requires capital, often enormous amounts by historical standards, with the result that income inequalities may become more marked where there are no political mechanisms of redistribution. Another difficulty is that, even with capital availability, the innovation of technology is slow. And, the people who can effectively use it are those who are the best off already.

Given the pace of change heretofore in the less developed countries, and the capital requirements for progress, the prospect for the future is mixed, and in some respects disheartening. It is clear that if we continue as at present, it will take today's poor countries (per capita income about \$200) about a century to achieve the living standards now enjoyed by today's advanced countries. Furthermore, the World Bank indicates that countries with a per capita GNP less than \$200 show a prospect of an actual decline in GNP, with present levels of external assistance. Increasing capital transfers to the poorest countries by a significant amount could change the projected negative growth rates into slightly positive ones, but all this time the advanced countries will be moving further ahead, since their growth rates are higher. Thus the capital transfer route also appears to offer a less than desirable prospect of answering the needs of the less developed countries.

While we might wish to consider this problem at our leisure, in fact it is an urgent one. Recent reports indicate that hundreds of thousands, perhaps millions, of our fellow human beings will not survive the next few years, for simple lack of food, at a time when the technologies for adequate food production are well known.

To summarize the problem, we can say: while on a world scale, capital is not short, for the less developed countries it is not available in quantities anywhere near the required size. New technologies, for example agricultural technologies, are available, but they are being adopted too slowly. The appropriate question thus is: holding capital constant, and assuming a backlog of unexploited techno-

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logies, how can change be accelerated? It is the answer to this question that millions of our fellows desperately require.

I have long pondered this problem, one which has intrigued me since my earliest newsletters almost two years ago. I have concluded that there is indeed a third way, that by relaxing some of our assumptions -- assumptions so basic we often never even verbalize them -- we can indeed affect dramatically the rate of innovation of modern technologies, and at the same time bring about great improvements in the distribution of income. The answer lies in altering the "institutional context" of innovation. Unfortunately, too often writers on economic development wave a magic wand of "institutional change," wonderful to behold in its abstractness, and then are disappointed when nothing happens. To avoid this problem I want to discuss institutional change in very specific terms, and to do this I will use a case study. My basic point is that altering the distribution of power between social groups, while holding everything else the same, may enhance the capacity to innovate new technologies. At the same time, we must recognize that there are potent forces preventing a recognition of this actual development alternative.

The case study I will examine here is the attempt by the Thai Public Welfare Department to innovate a new sericulture technology among poor rice farmers in Thailand's northeastern region. The Northeast is the poorest part of the kingdom, with a per capita income of only \$94 in 1972, 48% of the national average. Sericulture has long been practiced in the Northeast, but with a traditional technology whose returns are low. However there is considerable demand for Thai silk thread, exceeding what traditional production methods can supply. This fact led to hopes that the introduction of a new technology could raise incomes substantially and provide plentiful off-season employment.

I should note here that the new technology proposed for the poor farmers of the Northeast is exactly the one I described in my JEF-3, as employed by the Cul Cunvong Silk Farm of Phetchabun province. As I recorded then, in August 1973, the Cul farm was finding the new sericulture technology extremely profitable and was expanding as fast as possible. (Sombat, the owner, in fact asked me then if I wanted to invest some money in the silk project!) So there is no question that the new methods work, and make money. The point I was making in JEF-3 was that these profitable new technologies tend to be adopted by those already well off, not the poor, thus reinforcing and perpetuating income inequalities.

The point of the PWD scheme was to make this profitable new technology available to the poor farmers in the Northeast, but it failed. Herein lie some important lessons, which I want to share with you. (I am preparing a much more comprehensive and detailed analysis of this case for publication; it is titled "Turning Parameters into Variables in the Theory of Economic Growth: A New Appeal," and I can provide copies to anyone who is interested.) I did not visit the PWD project myself but base my conclusions on a study prepared by two scholars, Drummond Hislop and Michael Howes, from the Science Policy Research Unit of the University of Sussex, England.

For those unfamiliar with the way in which silk thread is produced, let me repeat the description I gave in JEF-3. Silkworm eggs are obtained (either locally or imported from Japan) and laid out on branches of the mulberry bush. The worms eat the mulberry leaves, at which point they are placed on a corrugated chicken wire screen to spin their cocoons. The cocoons are then roasted to kill the worms

and finally placed in hot water baths to locate the end of the long strand of silk. The thread is then unwound, twisted and dried, and prepared for shipment to the spinning mills.

The new technology proposed by the PWD, and actually used by the Cul farm, promised to increase incomes by a factor of ten, and consisted of the following five elements:

- \* A more productive variety of mulberry bush
- \* Improved methods of planting, pruning, fertilizing and weeding
- \* Improved silkworm varieties
- \* More hygienic rearing practices to lessen the risk of disease
- \* A new reeling machine to overcome an existing bottleneck in the conversion of the single cocoon thread into the multiple strand sent to the spinning mills.

Hislop and Howes, in their study, uncovered four reasons for the failure of the project. These were:

1. The reeling machine. The quality of the thread produced by the project's participants on the new reeling machines was largely unacceptable to the market, as a result of which they reverted to the much slower traditional reeling technique, which in turn placed a severe limit on the number of worms which could be raised. They point out, however, that the problem lay not in the reeling machines themselves, but in the skill of the operators: similar machines are used elsewhere, and one or two of the project families produced marketable thread as well.

2. The individual rearing houses. The traditional technology employed to rear worms called for raising them in baskets covered with cloth to prevent the entry of flies. This led to a high temperature in the baskets, and subsequent high incidence of disease, which was overcome by specially designed rearing houses, cool, sanitary, and, if maintained, free of flies. Unfortunately the rearing houses were not properly maintained, permitting flies to enter. Participants then reverted to covered basket culture, raising internal temperatures and increasing the incidence of disease.

3. Tardy capital infusions. The original plan had called for a government cash grant to finance the establishment of the mulberry plantation, but as the planting season approached, the money did not arrive. The participants were thus forced to improvise low-cost, and less productive, methods.

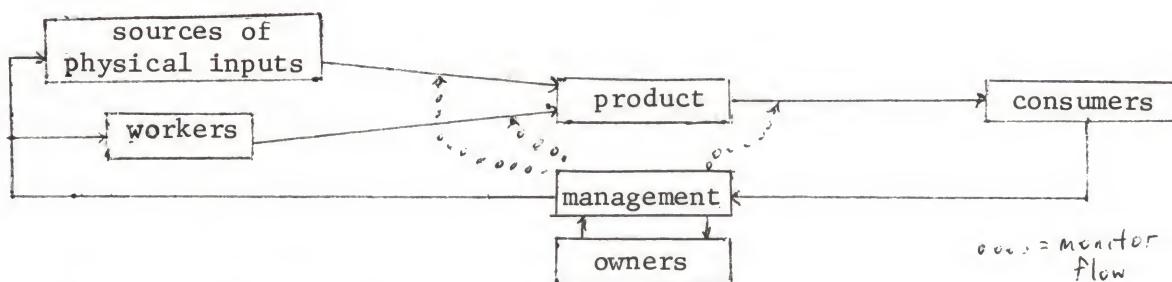
4. Breakdown of collective responsibility in joint production tasks. The project included two areas where group responsibility was employed: the maintenance of the central rearing house for young worms (different from the individual rearing houses mentioned above) and of the mulberry plantation supplying the central rearing house. While the former task succeeded, the latter did not. As Hislop and Howes report, "it is anticipated that land settlement officers will always be required to act in a supervisory capacity, since members are considered incapable of exercising responsibility in any collective sense. It is said that if left to their own resources, they will only perform work related specifically to their own worms." Yet, even with the supervision of the government officials, collective responsibility broke down in the mulberry plantation.

The standard way to approach a problem like this is to see a whole series of ad hoc causes for failure -- poor training, difficulties in bureaucratic coordination, low skill levels in terms of the project's technical sophistication, excessive haste in the face of financing and technical problems -- and then seek

a solution to each in its own terms. Or, despairing of success in this, one can throw up one's hands and say, the new technology is too complicated for these simple people with their demonstrated inability to cooperate with one another.

The alternative perspective which I propose is that these various reasons for the project's failure were all part of a larger problem, namely the failure to develop an institutional structure which would permit a proven and extremely profitable technology to take hold. We can thus look at this case study in two ways. According to the conventional wisdom of economic development analysis, the PWD scheme tested a new technology; the test failed due to excessive technological sophistication compared to the backward behavior of the people on whom it was tried; the indicated remedy is to revert to a simpler and less profitable technology for them, leaving the really profitable new technologies for the well-to-do. According to the perspective which I propose, the scheme tested whether a particular institutional structure can cripple the adoption of a proven and profitable technology; the test succeeded; the indicated remedy is to alter the institutional structure.

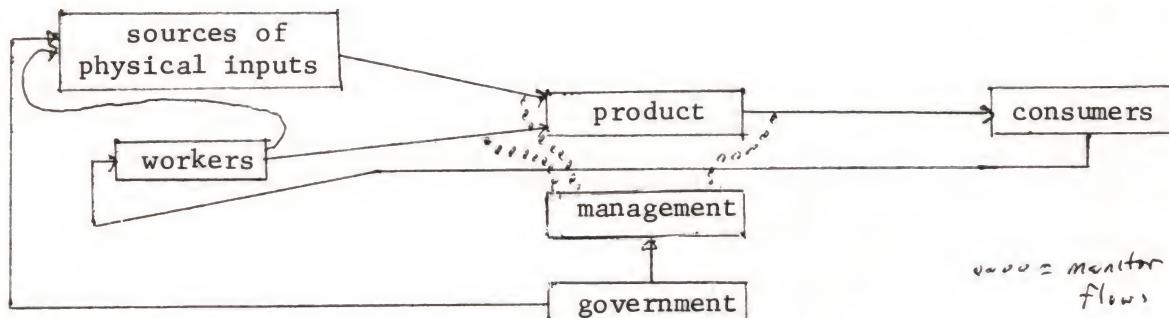
But let us be specific. How are these apparently different reasons for the project's failure related? For one, the project had a rather unusual management system, operated by civil servants assigned from the central bureaucracy. As such, one of the essentials of any successful enterprise was missing: a complete feedback loop which regulates various kinds of flows as required by the specific technology, and provides rewards to the various participants in proportion to their contributions. Without such a loop, people will not be motivated to do the right things, and the complex technology, no matter how profitable, won't produce. This is exactly what happened in the PWD project. Consider the following diagram:



In this structure, an exchange develops which makes all participants -- workers, management, consumers -- better off than if they did not participate. The proper functioning of the overall process is ensured by passing the loop through the management and providing that some proportion of the flows remain with management. This is a standard "business" management structure.

Contrast this with the second diagram, which represents the bureaucratic management structure chosen by the Public Welfare Department. In the PWD project, the management was omitted from the feedback loop, since in a bureaucratic system, as is well known, the incentives for the functionaries come from bureaucratic superiors and not as a percentage of the flows through one's sphere of authority. As a result, the bureaucratic managers had no incentive in the PWD sericulture project to solve assiduously all the myriad problems which invariably accompany any complex production process -- and which were solved by their non-

bureaucratic counterparts at the Cul Cunvong Silk Farm, using the first kind of management structure.



Furthermore, from the point of view of the workers (project members) there was no incentive to do their own private tasks well, for example maintaining their individual rearing houses, since they made no personal investments and bore no risks. They also had never experienced high returns from the new technology (indeed they had experienced only failures in their dealings with previous government projects), so there was no anticipation of future income to evoke group pressures to work diligently. In principle performance on individual tasks should have been motivated by the direct payments from consumers, but this flow depended on proper management by the project leaders, which as we have seen was precluded beforehand.

Hence it is not surprising that the proven technology failed to take hold: it is what any student of management would have predicted. Why government officials designed the project this way is the crucial issue, which we will discuss in a moment.

A second basic problem is that the "institution" set up to operate the new process, unlike the Cul farm, did not control all the resources essential to its success. While in a standard structure, capital resources are placed at the disposal of managers, in the PWD project, authority to commit these resources was retained at the central bureaucracy. Hence the untimely arrival of funds for the mulberry plantation condemned the project to a level of financial returns much lower than practically possible.

Let us also look beyond superficial appearances at the failure of "collective responsibility" as well. It is too easy to be patronizing and say that these were irresponsible farmers who will grow in responsibility when they become middle class people like the rest of us. It is also wrong to say this. Despite greater or lesser cultural difficulties, organizing for collective action is a universal necessity, and since the problem is solved everywhere, there are self-evidently means to do so. The means, in sociologists' jargon, is an "authority structure," and the ways to achieve an authority structure are also well understood.

The "standard" way to do this is for superiors to control the flow of material and non-material incentives to subordinates and, ultimately, to sever non-compliant subordinates from the organization. (Other factors enhance the ability of superiors to evoke compliance from subordinates, for example their personal qualities and individual technical competence, but I won't discuss these here.) We have seen, however, that because of the peculiar bureaucratic management structure of this project, those in charge didn't really regulate the flows of anything to anybody. Yet, there is an alternative, namely a "participant" authority structure, in which compliance

results from a common sharing in goals and rewards. Such systems can be extremely effective motivators, since strong peer pressures emerge to ensure that each participant executes his share of the collective task. If such an authority structure had emerged, the numerous problems encountered with the new technology could have been solved, with the technical assistance of the bureaucrats detailed from the central ministry. Moreover there would have been strong pressures exerted against such management lapses as the failure to take immediate corrective action when the market first began to reject the project's thread. This would have been the case because in this second kind of structure the authority of the leaders comes from relationships with the lower participants themselves, not from a set of outside linkages and the generalized status relationships of the larger society. In this case, on the contrary, the project's managers had little fear of failure, since their career incentives, salaries, and peer approval all came from an outside institution, their bureaucracy.

What led to these fatal institutional flaws? That is the crucial question. I suggest that these problems were not a random, chance result, not an "accident"; rather, the type of institutional structure which evolved was a necessary consequence of the political constraints on the project.

Let us consider the possibilities. One would have been to set the project up as a profit-making business, with capital funds to be borrowed on the open market, or loaned by the government in the first instance. In such a structure the risks are borne by the owners who also, of course, receive the entrepreneurial profits (in this case, large). The lower participants receive a wage set competitively within the larger economy. That is to say, the lower participants benefit by the new technology only to the extent of having an additional increment of employment at the going wage, while the enhanced income streams from the new technology flow to commercial elites.

This outcome is obviously not what the government had in mind. The effective alternative would have been the second type of structure we have described, in which authority is granted by the lower participants and management is accountable to these same people. In such a structure income increments from the successful adoption of the new technology would flow to the lower participants (i.e. non-elites), while management would be retained at a wage set by competitive market conditions for their skill level.

Yet this approach was not chosen either; what was chosen was a hybrid management structure which didn't work very well. Why? Here I believe the sociologists and psychologists have much to say that is relevant. Let me offer three suggestions from my own readings in these fields.

1. A participant authority structure on the second model would have been the reverse of the relationship existing in the larger society. That is, the bureaucratic model prescribes that middle-level civil servants, such as managed the PWD project, be subject to the authority of their hierarchical superiors in Bangkok, not low-power, bureaucratically rankless farmers. We know from experiments, many of them quite ingenious, carried out by "cognitive dissonance" theorists, that there are powerful pressures against thoughts, and ultimately behavior, contrary to firmly established values and beliefs -- in this case about the rightness and necessity of a hierarchical authority structure radiating out from the capital city, penetrating the countryside and controlling the smallest details of life there.

2. A participant authority structure would have placed low status people --

the project's poor members -- in authority over high power people -- the bureaucratic managers. We know from at least one body of experimental data that there are likewise pressures against this kind of situation arising, i.e., pressures toward maintaining "congruity" in the distribution of various values.

3. In either the "business" or the "participant" approach, the bureaucratic organs of the central government would have had to give up power, either relatively or absolutely. Thus, for one thing, the government would have had to give up authority over the capital funds (the failure to do which, we know, was one of the factors crippling the PWD effort). Also, relatively speaking, the establishment of an autonomous decision-making economic unit, with its own capital funds, controlling a profitable new technology, and possibly (in the case of the "participant" approach) dominated by low-status farmers, would have diminished the power of the central government. It might well have been a threat. Yet the voluntary cession of such powers is contrary to what we know about the behavior of institutions, namely that they seek to enhance their own power and autonomy.

This is an important point and I should say a bit more about it. Thailand, like other less developed countries, is a relatively undifferentiated society, and there are powerful "homeostatic" processes perpetuating this lack of differentiation. For example, the government owns one large bank, a jute factory, a tobacco monopoly, a trucking monopoly, a glass factory, a drug factory, and a host of other business enterprises. As I pointed out in my JEF-5, at the time of the October 1973 uprising in Thailand, there is also a parasitical penetration of the business sector by the political elite at almost every level. For example, until the 1973 uprising, the number two man in the military dictatorship was also the chairman of the board of the nation's largest bank. This lack of differentiation powerfully helps elites to maintain their dominant position, and the emergence of autonomy is by no means a speculative, remote or hypothetical threat.

Contrary to these self-serving processes favoring continued lack of differentiation are of course other processes favoring structural differentiation, increased autonomy, and dispersion of power. Ultimately the latter must triumph -- that is the meaning of development. Yet, though development is a wide-ranging and ultimately irresistible process, it can be delayed, and that is my concern here.

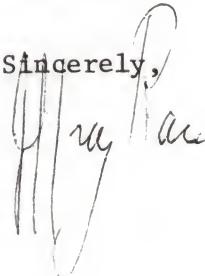
The point which I believe must be communicated here is that economic development through technological innovation is related both as a cause and a consequence to changes in the distribution of both income and power; hence, it is not easy to do. In the case I have looked at here, the attempt to place a profitable new technology in the hands of low-status, low-power, poorly educated, and impecunious farmers, ran afoul of the well-documented pressures to maintain congruity between the distribution of values on various continua, to protect the fit between behavior and beliefs, and to preserve the autonomy of existing power structures. Simply put, eliminating the sociologist's jargon words, the PWD project ran afoul of the processes perpetuating the elite structure of society.

Were Thai decision makers conscious of these relationships and the development alternatives they imply? Did they consciously choose to perpetuate their own power knowing it would frustrate the income goals they set? Almost certainly not -- but this is perhaps not the most useful way to pose the issue. Rather we can say that these subjects have been studied intensively for decades by sociologists of organizations, management theorists, and analysts of small group behavior. Sufficient

knowledge has long been available to avoid the elementary errors committed in the project analyzed here. Thus there is no apparent reason why the project leaders should not have known had they desired to. The conclusion that suggests itself is thus not that the decision makers chose failure, but that failure was the necessary consequence of the political constraints which they saw necessary to impose on the institutions created to employ the new technology on behalf of the poor farmers.

Thus we can understand, in a way, why Thai leaders did what they did: the problems arose because of a failure to articulate conflicts between economic and political goals (goals which, we must hasten to add, were not articulated either). What is harder to understand is why, if political leaders committed to a certain kind of society benefitting themselves did not articulate this conflict, economic development theorists -- supposedly committed only to truth -- did not do it for them. My purpose in this letter is thus principally to draw attention to a serious anomaly in the economic development literature, namely that the bulk of the research and operational attention appears to ignore the large economic benefits which would flow from a relaxation of political constraints. Further, the economists would have to do no original research themselves, but simply read the findings of their colleagues in allied fields. This does not even mean that scholars of economic development have to prescribe such political changes: the role of the man of truth is help us understand the structure of the world, so that we can make intelligent and informed choices among means. The fact that this was certainly not done for the PWD project by the horde of development economists working for the Thai government, and seems more generally not to be done in the scientific literature, raises in my mind the most serious questions about the real commitments of my fellow scholars in the field of economic development. Yet I may be too unkind here, and I would certainly like to hear from anyone who has contrary views.

Sincerely,

A handwritten signature in black ink, appearing to read "John C. Turner". The signature is fluid and cursive, with "John" on the left, "C." in the middle, and "Turner" on the right.



The mulberry plant



Mature silkworms ready to be transferred to spinning racks (see next photo)



Completed cocoons being taken off the spinning racks and prepared for roasting



A reeling machine. This one is the type used at the Cul Cunvong Silk Farm and is more complicated than the one employed by the PWD sericulture project.

Received in New York on May 9, 1975